

NOURYON

Diverse and sustainable potash mining reagents

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Typical sylvite flotation test in Nouryon's application lab.

Potash mining and processing are important initial steps in the value chain that produces fertilizers and ultimately food. Nouryon offers products that can assist at nearly every step in the production of high-quality potash concentrate from potash ore. These boost process performance and help reduce adverse environmental impacts along the way.

Introduction

Potash is a water-soluble mineral salt valued for its potassium content that is almost always accompanied by sodium and magnesium chloride¹. Potassium is a crucial crop nutrient in agriculture. It can

be applied directly as 'straight' potassium chloride (KCl, known as sylvite or muriate of potash, MOP) or potassium sulphate (K_2SO_4 , commonly known as sulphate of potash, SOP). It is also incorporated and applied alongside other primary nutrients in NPK blends and complex NPK fertilizers.

MOP is the most widely consumed potash fertilizer – with demand from around the world exceeding 55 million tonnes annually². This type of potash is primarily applied to broad acre crops and chloride-loving vegetables such as sugar beet and corn. It also helps to build disease resistance in plants².

SOP, meanwhile, has the advantage of combining two key plant nutrients: potas-

sium and sulphur. This premium quality product can be extracted from mineral deposits (primary SOP) as well as manufactured chemically (secondary SOP). SOP is ideal for chloride-sensitive crops, improving both quality and yields, while also making plants more resilient to drought, frost, insects, and disease. In addition, SOP is known to enhance the appearance and taste of vegetables and boost crop uptake of other essential nutrients such as phosphorus and iron. For these reasons, SOP is commonly used on high-value crops such as fruits, vegetables, nuts, tea, coffee and tobacco².

Potash production is dominated by the underground mining and surface processing of MOP. This predominant type of potash is also converted to SOP via the chemical Mannheim process. This synthesis method involves reacting MOP with sulphuric acid in a muffle furnace and heating to above 600°C. Alternatively, SOP can be manufactured by reacting potassium chloride with various sulphate compounds. These form a double salt from which it is possible to make SOP plus sodium chloride².

Enhancing potash recovery

As a global leader in specialty chemicals, Nouryon possesses more than 50 years of expertise in mineral processing functions, such as flotation collectors, depressants, and processing aids, with solutions to enhance the recovery of a variety of ore types – including calcite, phosphate, iron, silicate, graphite, sulphide, and potash.

"We partner with our customers to deliver essential solutions for a sustainable future," says Brad Pearson, global marketing director at Nouryon.

Table 1: Nouryon’s mining product range for potash ores

Ore type	Ore characteristics	Product name	Function
Sylvinite (direct flotation)	Mixture of halite and sylvite	Armeen® HT	Fatty amine collector for wintertime (cold brines)
		Armeen® M	Fatty amine collectors for summertime (warm brines)
		Lilaflot® FAB53	
	Various clay/slime content	Ethomeen® HT/40	Slime collectors
		Berol® range	
		Phospholan® PE65	Anionic clay/slime collector
		Celect® SD	Clay/slime depressants and blinding agents
Finnfix® 300			
Carnallite (reverse flotation)	Mixture of carnallite and halite (potassium, magnesium and sodium chlorides)	Armoflote® 619 (reverse flotation)	Selective and unique halite collector
Schoenite (reverse or direct flotation)	Mixture of schoenite and halite (potassium/magnesium sulphate and sodium chloride)	Lilaflot® D817M (direct flotation)	Cationic schoenite collector
Potash concentrate		Armeen® O	Anticaking
		Armeen® HT	
		Armeen® T	
		Armeen® M	
		Armoflo® AC-59P	

Source: Nouryon

The froth flotation challenge

Processing potash ore by separating off its different components can be a challenge as many of these are water-soluble. However, this processing challenge can be met and overcome by selecting the right froth flotation technique – as this enables improved separation performance in a cost efficient way.

Nouryon, for example, offers innovative and individually customised flotation agents for unique ores including potash. These deliver superior performance combined with a strong focus on sustainability. These capabilities are possible thanks to decades of mineral processing expertise and the company’s track record of customer collaboration.

For Nouryon, environmental stewardship – and the creation of more value for its customers – starts with the sustainable sourcing of bio-based raw materials. Nouryon has a broad portfolio of flotation agents for the potash industry. The company’s main potash processing products are listed in Table 1 together with their respective functions.

The use of selective collectors that efficiently make mineral surfaces hydrophobic – and therefore susceptible to separation

– is critical for successful flotation. To this end, Nouryon has designed and developed several collectors suitable for diverse potassium-bearing minerals and conditions. Many of these are based on fatty amine technology, one of Nouryon’s core areas of expertise.

“Nouryon’s individually customised flotation agents for potash deliver superior performance combined with a strong focus on sustainability.”

“Our collectors can efficiently balance recovery and selectivity during the flotation of sylvite from sylvinite in MOP production across a variety of ore types, brine compositions, and process temperatures,” says Henrik Nordberg, global section manager for mining at Nouryon.

Figure 1 illustrates the performance

of amine blends used in potash flotation, while a typical sylvite flotation test is shown in the article’s main photo.

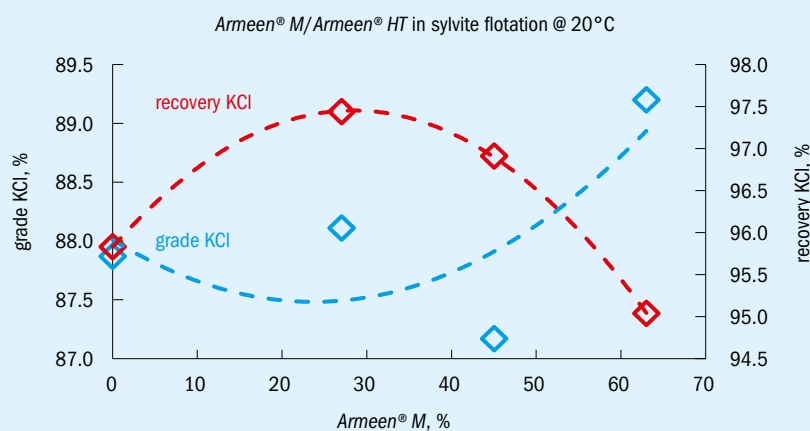
Reverse flotation for halite removal

Nouryon’s *Armoflote® 619* collector is unique, as it enables the successful reverse flotation of halite (sodium chloride) from carnallite (a potassium chloride and magnesium chloride mixture) and other double salts such as schoenite (a mixture of potassium and magnesium sulphates). In reverse flotation, the unwanted gangue mineral is floated while the valuable mineral remains as the bottom product. When used as collector in carnallite flotation, *Armoflote 619* exhibits an impressive ability to remove halite from the valuable potash-bearing mineral (Figure 2).

Removal of slimes

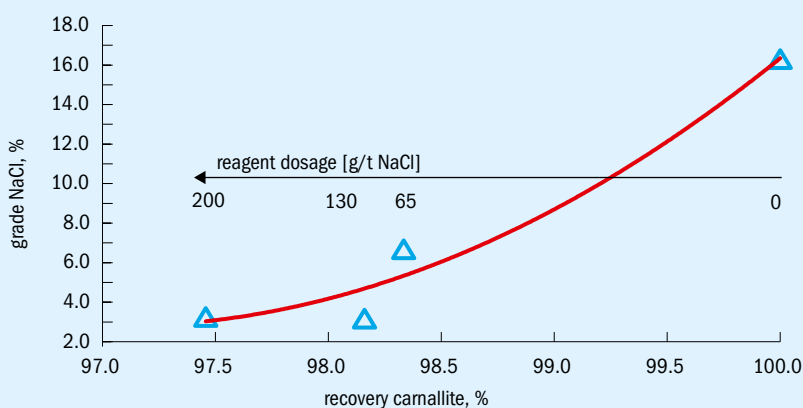
Certain potash ores contain clay minerals in addition to the salt minerals that typically occur. These fine clay particles – also known as slimes – negatively impact potash flotation due to their high charge and high surface area. This prevents separation by depleting collector concentration. Solutions to this problem include:

Fig. 1: Performance of Nouryon's Armeen® M/Armeen® HT collector blend in sylvite flotation: typical grade-recovery curves



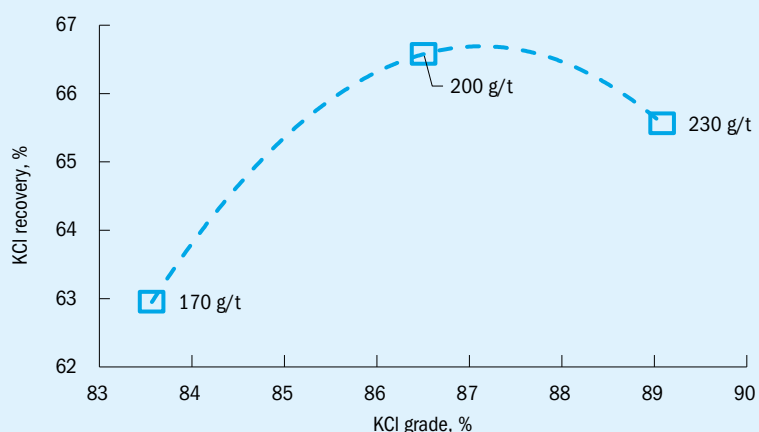
Source: Nouryon

Fig. 2: Separation of carnallite from halite by reverse flotation using Nouryon's Armoflote® 619 collector



Source: Nouryon

Fig. 3: Use of Celect® CMC depressants to optimise sylvite recovery



Source: Nouryon

- Mechanical desliming using hydro separators and cyclones
- Physico-chemical separation via slime flotation or the use of a depressant that blocks slime surfaces from interfering with sylvite flotation.

Of these two options, physico-chemical separation via flotation is usually preferred, since mechanical desliming causes the loss of fine potash particles, while total potash recovery can also be improved through selective reverse flotation of the slimes. A range of products demonstrates Nouryon's proficiency with slime collectors. These include *Ethomeen® HT/40* and *Berol®* non-ionic collectors as well as the *Phospholan® PE65* anionic collector.

Nouryon is also a leading global manufacturer of carboxymethylcellulose (CMC) depressants (*Celect®* and *Finnfix®*) for mining applications. This enables the company to maximise recovery grade profiles for its customers by offering holistic and individually tailored flotation options. CMC, a bio-based anionic polymer, functions as an efficient depressant in the flotation of a wide variety of minerals, including potash. CMC optimises sylvite recovery (Figure 3) by ensuring that flotation collectors are fully adsorbed on the surface of the target mineral by 'blinding out' the active surface area of clays.

Potash coating

Once successfully separated via froth flotation, the high quality potash concentrates obtained need to be prepared for storage and transportation. This is usually achieved by applying a mineral coating, typically an anticaking agent, to prevent potash adsorbing water and becoming lumpy and sticky. Nouryon offers a range of anticaking agents (*Armeen® HT*, *Armeen® T*, *Armeen® O*, *Armeen® M*, and *Armoflo® AC-59P*) which use fatty amine technology to preserve potash concentrates in their desired form until they reach their ultimate destination. ■

References

1. Garrett, D., 2012. *Potash: deposits, processing, properties and uses*. Springer.
2. Pistilli, M., 2021. *Potash Fertilizers: What's the Difference Between SOP and MOP?* Agricultural Investing News. 22 June 2021. Accessed: 4/1/2021.